Even though the lockup engagement was under specification, the contact vector between the barrel catch and the barrel lug passed through the center of the barrel catch pivot, positively locking the action. See Figure 8.2.4. When the contact vector runs through the center of the barrel catch pivot, theoretically no amount of contact force can induce an opening torque on the latch. Therefore, if the barrel catch is engaged per the CT scan, the only way to open the barrel via force would require the barrel catch and/or barrel lug to be deformed such that the contact vector was significantly changed, or the two parts no longer engaged one another. No such damage was observed on either part. The lack of damage on the barrel catch and barrel lug indicates the rifle was not locked at the time of the incident.

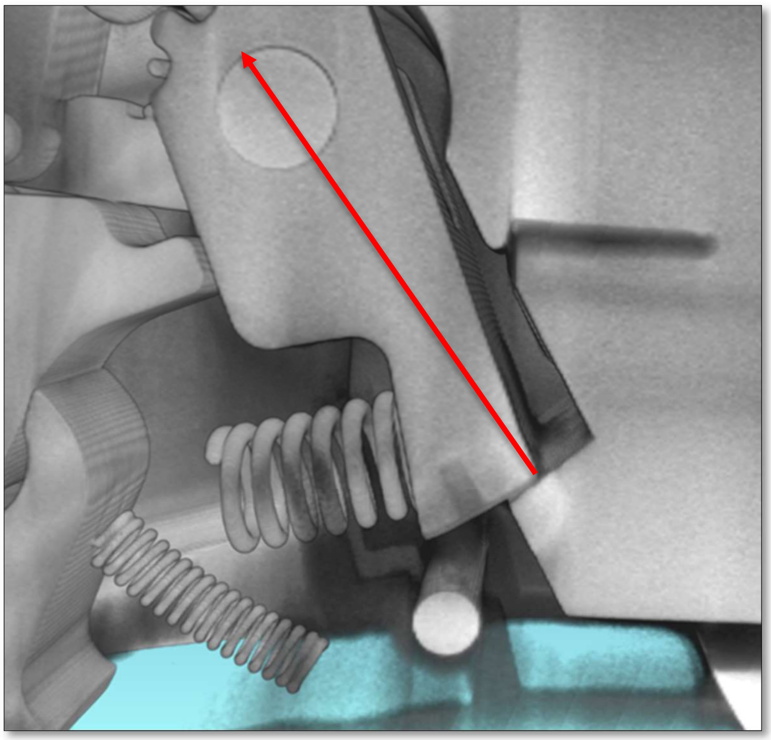

Figure 8.2.4: Contact Vector Between the Barrel Catch and The Barrel Lug

When the CT scans and x-rays were completed, the rifle was dismantled and examined. Every rifle that leaves Remington's factory is proof tested to verify the integrity of the lockup and then fired with normal ammunition to check function. A 300 Blackout proof round produces a MAP of 78,500 psi, a pressure 42.7% greater than the SAAMI allowed 55,000 psi. The Remington proof mark on the underside of the subject barrel indicates the integrity of the rifle's lockup was tested and proven capable of withstanding a minimum of a 42.7% over pressure event without failing.

Examination of the barrel lug showed wear marks where the barrel catch had been engaged. As discussed earlier, the barrel catch is curved and the wear marks on the barrel lug represent the contact points between the two components, but not the amount of overlap between the barrel catch and barrel lug. The engagement wear marks were

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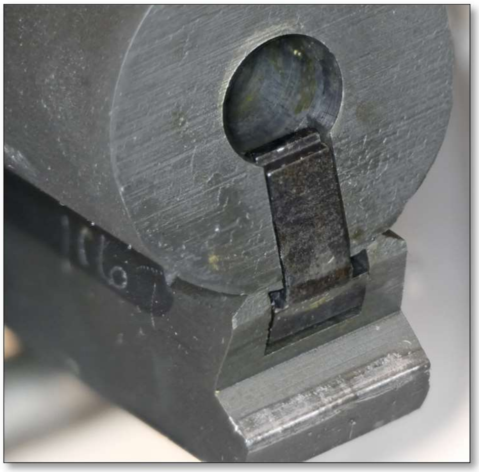
measured to be approximately 0.074 inches, which is 0.012 inches greater than the measured engagement shown on the CT scan. This means the barrel catch had been engaging the barrel lug to a greater degree at some time before Mr. Powell requested the rifle not be opened and the lockup disturbed before the CT scan. It is unknown if the below specification lockup was staged for the purposes of the CT.



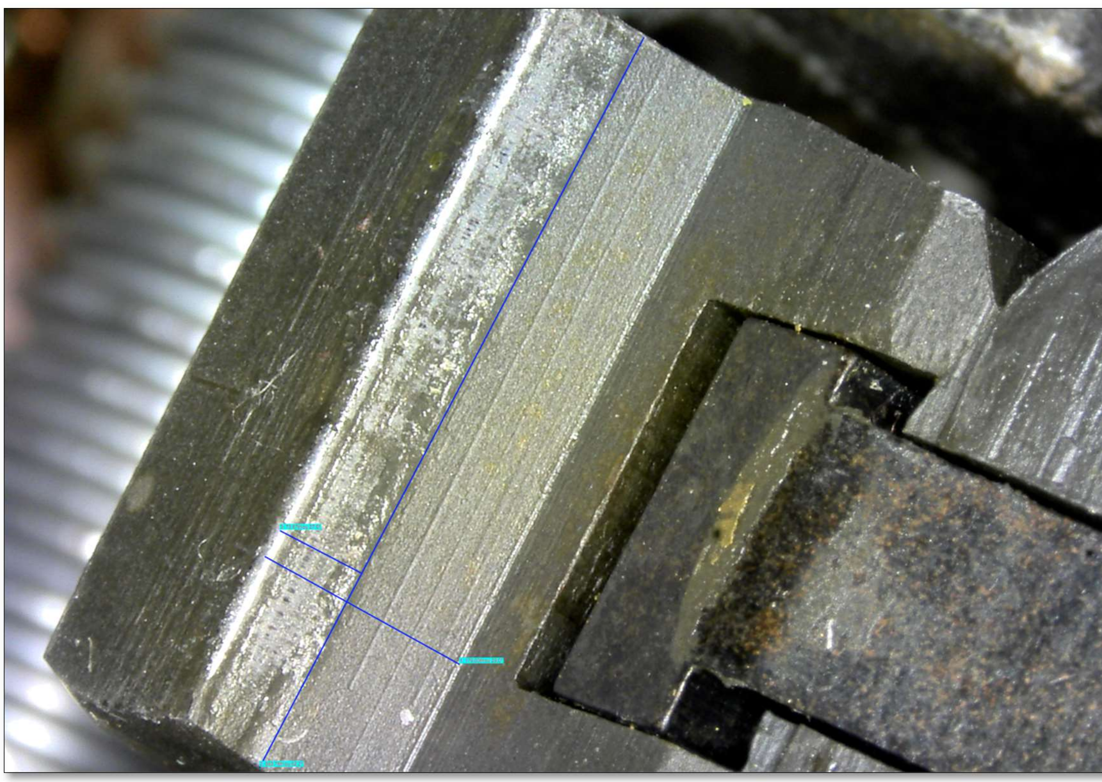


Figure 8.2.5: Engagement Wear Marks on the Barrel Lug

No physical evidence was found to suggest the rifle is defective and dangerous. The engagement measured was more than adequate for the rifle to perform safely and for its intended purpose.

9) Root Cause Analysis of Mr. Batts Incident via the Scientific Method

The scientific method is the cornerstone for separating conjecture from fact. The scientific method consists of forming a hypothesis using scientific and engineering principles, and then testing that hypothesis in an objective manner that can be verified independently. Competent engineers and scientists employ the scientific method on a regular basis to validate their designs and opinions. Conversely, the scientific method can also be used to prove a hypothesis/opinion to be false.

Mr. Powell has put forth the opinion that Mr. Batts was injured because a subsonic SAAMI compliant round of ammunition was discharged in the incident rifle, which he claims was dangerously defective due to a compromised lockup of approximately 0.062 inches. Mr. Powell's opinion directly contradicts the analytical analysis I have put forth that shows a H&R Handi-Rifle will not open and forcefully expel the shell of a discharged SAAMI compliant cartridge, even if the rifle is discharged in the unlocked condition (section 5). To date Mr. Powell has produced no testing or scientific data to support his opinion of root cause.

I have put forth the root cause opinion/hypothesis that Mr. Batts was injured because he discharged an improperly hand loaded subsonic round of 300 Blackout ammunition. The geometry of the improperly loaded incident cartridge prevented the subject rifle from locking and the improper propellant produced inadequate pressure to propel the bullet from the barrel, causing the bullet to become lodged in the barrel and the subsequent trapped pressure to open the unlocked action and expel the discharge shell into Mr. Batts' eye. In this section of the report I will discuss the scientific, real-world testing I conducted to test (and which validates) my analytical analysis. The testing proves my opinion of root cause and disproves Mr. Powell's opinion of root cause. A list of all the testing can be found in Appendix A.

9.1) <u>Factory 300 Blackout Ammunition Fired in an Unlocked H&R Handi-Rifle</u>

The most straight forward way to determine if Mr. Powell's opinion that the subject H&R Handi-Rifle opened when a SAAMI compliant cartridge discharged and expelled the incident shell is through the live firing of an exemplar rifle equipped with a compromised lockup of approximately 0.061 inches. However, my hypothesis was (is) that the subject rifle would not have expelled the shell, even if unlocked. Therefore, discharging SAAMI compliant 300 Blackout ammunition in an unlocked exemplar H&R Handi-Rifle (0.000 inch engagement) would be a worst case test condition for both root cause opinions/hypotheses.

To configure an exemplar test rifle to discharge in the unlocked condition, shims were placed under the barrel to prevent the barrel from closing completely and from allowing the barrel catch to engage the barrel lug. The rifle was then discharged remotely via a

lanyard while being constrained from side-to-side, but allowed to open freely. The testing was recorded with standard 1080p video and highspeed video (10,000 and 20,000 fps). See Figure 9.1.1.

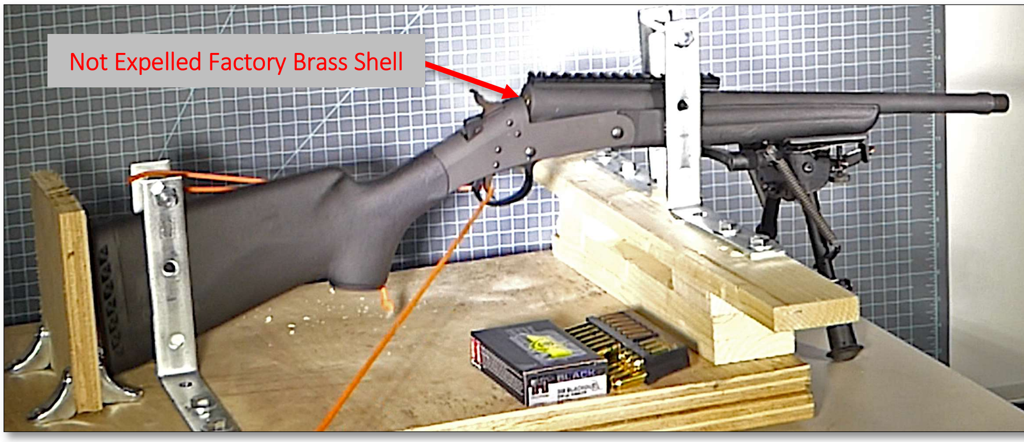


Figure 9.1.1: The Factory Hornady Subsonic 300 Blackout Shell was not Expelled from the Discharged and Unlocked Exemplar H&R Handi-Rifle

Factory ammunition from Winchester, Federal, Hornady, Sig and Remington were discharged in both supersonic and subsonic configurations. See Figure 9.1.2. A total of 49 factory 300 Blackout cartridges were discharged in the unlocked exemplar rifle (0.000 inch engagement between the barrel lug and the barrel catch). The average subsonic bullet-in-barrel time was calculated to be of approximately 1.3 milliseconds and in every test, the bullet exited the barrel before the action started to open. See Figure 9.1.3.

Ammunition Brand	Type	Shots Fired	Bullet Lodged in the Barrel	Brass Ejected	Notes
Winchester	Supersonic	3	No	No	Part of the full testing 2019
Winchester	Subsonic	3	No	No	Part of the full testing 2019
Federal	Supersonic	3	No	No	Part of the full testing 2019
Federal	Subsonic	3	No	No	Part of the full testing 2019
Hornady	Supersonic	5	No	No	Part of the full testing 2019
Hornady	Subsonic	4	No	No	Part of the full testing 2019
Sig	Supersonic	7	No	No	Was part of the base testing in 2017 and the full testing in 2019
Sig	Subsonic	7	No	No	Was part of the base testing in 2017 and the full testing in 2019
Remington	Supersonic	7	No	No	Was part of the base testing in 2017 and the full testing in 2019
Remington	Subsonic	7	No	No	Was part of the base testing in 2017 and the full testing in 2019

Figure 9.1.2: 300 Blackout Factory Ammunition Testing in a H&R Handi-Rifle with a 0.000 Lockup

In none of the tests was the discharged shell expelled from the chamber. The highspeed video clearly shows that the action only starts to open well after the bullet has left the barrel and the rifle is recoiling forward after bottoming out the recoil pad. The initial recoil energy drives the rifle straight back and no discernable opening of the action can be observed. The action only begins to open when the rifle recoils forward off the test

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fixture's stop. The resulting opening of the action is due to the restoring energy from the test fixture and the recoil pad of the stock. The time between the bullet leaving the barrel and the action opening allows the barrel residual bore pressure to dissipate to a degree that the shell cannot be expelled.

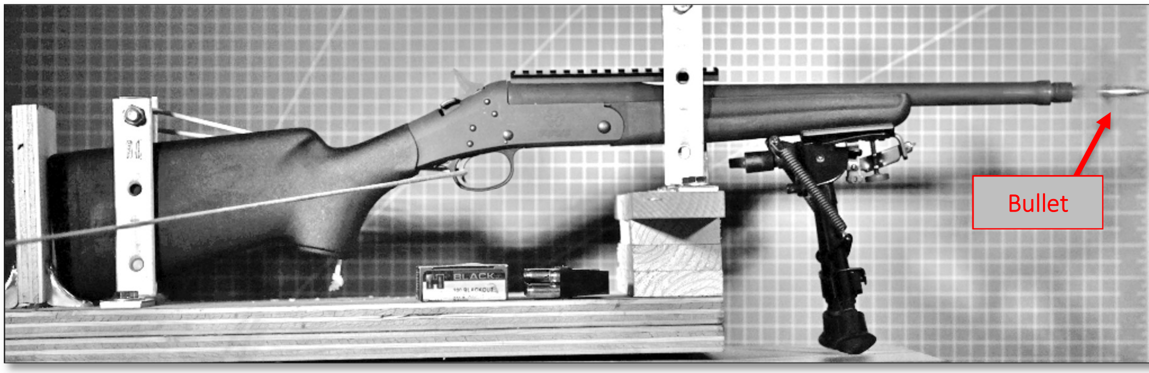

Figure 9.1.3: Factory Hornady Subsonic 300 Blackout Cartridge (208 grain Bullet) Discharged in an Unlocked Exemplar H&R Handi-Rifle

The 49 test firings of factory 300 Blackout ammunition through an unlocked H&R Handi-Rifle disproves via the scientific method Mr. Powell's rendered root cause opinion. Discharging SAAMI compliant 300 Blackout ammunition in an H&R Handi-Rifle with a compromised lockup (0.062 inch engagement) will not induce the rifle's action to open and the discharged shell to be expelled, lodging the bullet in the barrel. Examination of videos and photos from Mr. Powell's produced file clearly show Mr. Powell had the ability to fire an exemplar H&R Handi-Rifle remotely and the knowledge to compromise the rifle's lockup using shims. It appears Mr. Powell chose not to conduct testing to examine his rendered root cause hypothesis.

9.2) <u>Underpowered Subsonic 300 Blackout Ammunition</u>

Because SAAMI compliant factory ammunition will not lodge a bullet in the barrel and cause the discharged shell to be expelled, the question remains, "What ammunition and rifle condition can cause the bullet to lodge in the barrel, the rifle's action to open and forcefully expel the discharged shell?" I have put forth the opinion that an underpowered subsonic 300 Blackout cartridge discharged in an unlocked rifle (0.000 engagement between the barrel lug and barrel catch) can cause the bullet to become lodged, the rifle's action to open and the discharged brass to be forcefully expelled, but, if engagement exists between the barrel lug and barrel catch, the shell would not be expelled because the action will remain closed. To test this hypothesis 10 Hornady factory subsonic cartridges were torn down and their propellant was measured. Nine of the Hornady cartridges were then built back up with the factory subsonic components, but the propellant was varied by weight from 90% to 10% of a full charge. The test cartridges were then discharged in the

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unlocked exemplar rifle (0.000 engagement). See Figure 9.2.1. The testing was recorded with standard 1080p and highspeed video (20,000 fps).

Factory Propellant Charge	Lockup Engagement	Bullet Lodged in the Barrel	Shell Expelled
90% Factory Propellant	0.000 inches	No	No
80% Factory Propellant	0.000 inches	No	No
70% Factory Propellant	0.000 inches	No	No
60% Factory Propellant	0.000 inches	No	No
50% Factory Propellant	0.000 inches	No	No
40% Factory Propellant	0.000 inches	Yes	Yes

Figure 9.2.1: Factory Hornady Subsonic 300 Blackout Ammunition (208 grain bullet) Downloaded and Discharged in an Unlocked Exemplar Handi-Rifle.

The bullet did not become lodged in the barrel and the shell expelled from the chamber until the propellant charge was reduced to 40% of the factory charge. This testing showed the bullet must become lodged in the barrel before the pressure produced by the burning propellant will have enough time to force the action open and forcefully expel the discharged shell from the chamber. See Figure 9.2.2. This testing also conclusively proves the order of events with respect to the bullet stopping and the action opening. To produce enough force against the breech face long enough for the action to open, the bullet must lodge in the barrel first. Mr. Powell testified the action was opening and releasing the pressure, which in turn caused the bullet to stop and become lodged in the barrel. Mr. Powell's testimony is directly refuted by this testing.

Figure 9.2.2: Highspeed Video Frame of Factory Hornady Subsonic 300 Blackout Ammunition (208 grain bullet) Downloaded to 40% Propellant and Discharged in an Unlocked Exemplar Handi-Rifle.

Thus far, this testing has proven only the first part of my hypothesis. The second part of my hypothesis was that if the action was locked, even partially locked, the shell would not have been expelled after the bullet became lodged in the barrel from the underpowered cartridge. To test this portion of my hypothesis shims were once again employed to adjust the exemplar rifle's lock engagement below 0.060 inches, an engagement below Mr. Powell's claim of engagement at the time of the incident. See Figure 9.2.3.

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Figure 9.2.3: The Exemplar Test Rifle's Lock Engagement Set Below 0.060 inches.

Three factory Hornady Subsonic 300 Blackout cartridges were then rebuilt with a 40% factory propellant charge. Each test cartridge was then discharged in the exemplar rifle with the compromised lockup. Each cartridge lodged the factory 208 grain bullet in the barrel but did not expel the brass from the chamber. See Figure 9.2.4. The lock remained engaged with the action closed on each discharge, even with the lock engagement set below 0.060 inches.

Factory Propellant Charge	Lockup Engagement	Bullet Lodged in the Barrel	Shell Expelled
40% Factory Propellant	Less than 0.060 inches	Yes	No
40% Factory Propellant	Less than 0.060 inches	Yes	No
40% Factory Propellant	Less than 0.060 inches	Yes	No

Figure 9.2.4: Factory Hornady Subsonic 300 Blackout Ammunition (208 grain bullet) Downloaded to 40% Propellant and Discharged in an Exemplar Handi-Rifle with Lock Engaged to Less than 0.060 inches

To illustrate the performance differences between a factory Hornady Subsonic 300 Blackout round of ammunition and the same round ammunition downloaded with a 40% propellant charge, two such rounds were discharged in a calibrated 300 Blackout pressure barrel. See Figure 9.2.5. The factory Hornady cartridge developed a max pressure of approximately 31,000 psi and the 208 grain bullet had a barrel time of approximately 1.3 milliseconds. The 40% downloaded Hornady subsonic cartridge had a peak pressure of approximately 7,500 psi and infinite barrel time because the 208 grain bullet became lodged in the barrel. The pressure required to keep a bullet moving and the pressure required to restart a bullet moving are dramatically different due to the differences in static and kinetic friction coefficients. Examination of the pressure curve indicates the bullet became lodged in the barrel when the pressure initially stalled at approximately 5,000 psi.

The pressure generated by the burning propellant in a cartridge not only serves to propel the bullet, it must also overcome the frictional drag forces between the bullet and the rifling of the barrel. The drag forces depend greatly on the size of the bullet, the length of the bullet, and the geometry of the rifling to name a few variables. These drag forces also vary dramatically depending on where the bullet is in the rifling. When the bullet enters the rifling the drag forces are typically at their greatest because the bullet is being formed

to the rifling. When the bullet reaches the end of the rifling, the drag forces are typically at their lowest because the bullet is well shaped. The testing shows the energy required to form a 208 grain 300 Blackout bullet to the rifling and propel it down a 16 inch barrel is greater than a 40% factory Hornady propellant charge can deliver. Mr. Batts was not injured by a SAAMI compliant cartridge of ammunition producing pressures in the 30,000 psi range, but rather by an improperly loaded cartridge producing pressures less than half the measured factory pressure.

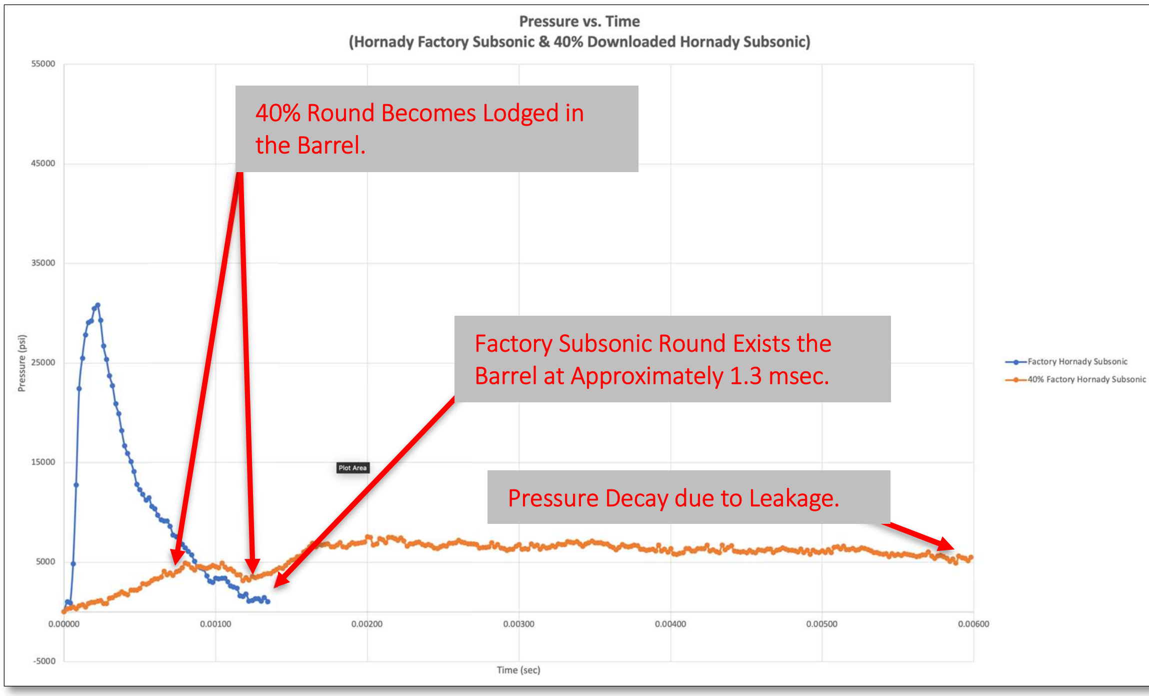

Figure 9.2.5: Pressure vs Time Curves for a Factory Hornady Subsonic 300 Blackout Cartridge and a 40% Downloaded Hornady Subsonic 300 Blackout Cartridge.

The live fire testing of downloaded Hornady subsonic 300 Blackout ammunition showed Mr. Batts' rifle expelled the shell because the improper hand loaded incident round of ammunition had been discharged in a fully unlocked rifle. As discussed earlier (Section 6) the contact vectors on the H&R Handi-Rifle's lockup do not promote the rifle to unlock under load, even when the lockup's engagement has been minimized. Mr. Batts' rifle showed no damage or physical evidence that would suggest the rifle had been forced open. For a H&R Handi-Rifle to unlock due to pressure, the lockup must be disengaged. The physical evidence indicates Mr. Batts' rifle was unlocked at the time of the incident because of improperly remanufactured shells and improperly loaded cartridges.

9.3) <u>The Effect of Adding CLP to the Chamber of a H&R Handi-Rifle</u>

The recovered video from Mr. Batts' GoPro memory card showed that Mr. Batts added CLP oil (Cleaner Lubricant Preservative) to the chamber of his rifle after he removed the bore

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obstructing bullet from the first shot. By adding the oil to the barrel, Mr. Batt's lubricated the rifling of the barrel, presumably to reduce the friction encountered by the bullet as it traveled down the bore. Pouring the oil into the barrel via the chamber had the side effect of lubricating the chamber and reducing the friction between the chamber walls and the shell. When the cartridge discharges, the resulting pressure that propels the bullet down the rifling also obturates the shell and presses it against the chamber walls. By reducing the friction between the chamber and shell, the thrust force exerted on the breech face of the rifle by the discharged shell is increased. Theoretically, the increased thrust forces can serve to increase the forces the rifle's lockup must resist to keep the rifle closed.

Ammunition Brand	Type	Engagement	Shots Fired	Bullet Lodged in the Barrel	Shell Expelled
Winchester	Supersonic	0.000	1	No	No
Winchester	Subsonic	0.000	1	No	No
Federal	Supersonic	0.000	1	No	No
Federal	Subsonic	0.000	1	No	No
Hornady	Supersonic	0.000	1	No	No
Hornady	Subsonic	0.000	1	No	No
Sig	Supersonic	0.000	2	No	No
Sig	Subsonic	0.000	1	No	No
Remington	Supersonic	0.000	2	No	No
Remington	Subsonic	0.000	2	No	No
Winchester	Supersonic	Less than 0.060	1	No	No
Winchester	Subsonic	Less than 0.060	1	No	No
Federal	Supersonic	Less than 0.060	1	No	No
Federal	Subsonic	Less than 0.060	1	No	No
Hornady	Supersonic	Less than 0.060	1	No	No
Hornady	Subsonic	Less than 0.060	1	No	No
Sig	Supersonic	Less than 0.060	1	No	No
Sig	Subsonic	Less than 0.060	1	No	No
Remington	Supersonic	Less than 0.060	1	No	No
Remington	Subsonic	Less than 0.060	1	No	No

Figure 9.3.1: Factory 300 Blackout Ammunition Live Fire Testing with a CLP Lubricated Chamber

To test the effect adding CLP to the chamber would have on the lockup of a H&R Handi-Rifle, the testing conducted earlier with factory SAAMI compliant 300 Blackout ammunition was conducted again with the chamber of the rifle lubricated with CLP before each shot. See Figure 9.3.1. To maximize the coverage of the CLP, a chamber mop dunked in CLP was used to apply the lubricant to the chamber. Using the chamber mop to apply the lubricant to the chamber had the added effect of lubricating the lockup, which should promote the lockup to unlock if the resulting forces were oriented to do so. See Figure 9.3.2. The testing was conducted with the exemplar rifle unlocked and locked with less than a 0.060 inch engagement. The testing showed that adding CLP to the chamber did not cause the rifle to open when shooting factory SAAMI compliant ammunition.

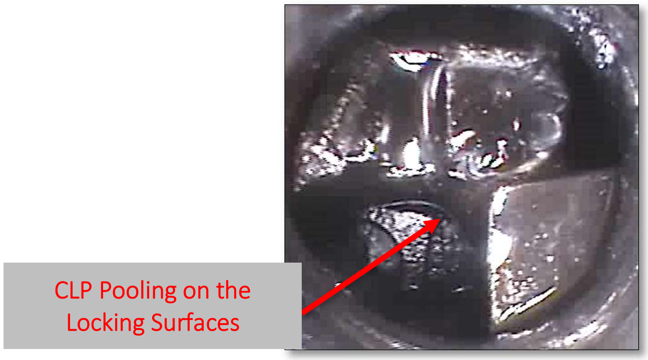

Figure 9.3.2: CLP Lubricated Locking Surfaces

9.4) <u>300 Blackout Ammunition Loaded with 308 Win Propellants</u>

Mr. Batts provided video of himself shooting a M1A rifle approximately 20 minutes prior to the incident. In the video it appears he is shooting hand loaded ammunition, ammunition that appears to be the same as the rifle ammunition be being loaded in the photo taken from his Facebook page. The M1A shoots military 308 Winchester service rounds of ammunition. These facts beg the question, "What if the incident 300 Blackout (208 grain bullets) ammunition had been loaded with the wrong type of propellant, rather than with just not enough propellant?" The propellants used in 5.56 mm NATO and 308 Win can have substantially different burning characteristics than propellants used in 300 Blackout subsonic ammunition. Specifically, the 300 Blackout propellants tend to burn much faster as the cartridge was initially developed to work in a 9-inch barrel, rather than the 20-inch barrels in which the 5.56mm NATO and 308 Win cartridges were designed to work.

National Center for Forensic Science (NCFS)					
Propellant Database Search					
Flattened Ball with Oblongs					
		QuickLoad Calculations (10.3 grains)			Notes
	Propellant	Max Pressure (psi)	Muzzle Velocity (ft/sec)	Percent Fill	
1	Accurate 2230	12546	865	78	Matches Shell #3 with respect to geometry. 56/6% Propellant Burnt
2	Accurate 2460	11952	866	78.4	
3	Accurate 2520	11269	839	80	Matches Shell #3 with respect to geometry. 50.5% Propellant Burnt
4	Accurate 2700	10872	764	80.9	
5	Accurate 8700	5594	494	80.9	
6	Accurate MagPro	7365	617	79.4	Matches Shell #3 with respect to geometry. 22.51% Propellant Burnt
7	Accurate MR-223				Not in the QuickLoad database
8	Accurate No. 2 Improved	216051	1648	127.3	Above SAAMI MAP 55kpsi
9	Accurate No. 5	107075	1573	81.7	Above SAAMI MAP 55kpsi
10	Accurate No. 7	69200	1500	78.8	Above SAAMI MAP 55kpsi
11	Alliant Power Pro 2000MR				Not in the QuickLoad database
12	Hodgdon CFE 223	10726	793	77.4	
13	Ramshot-Tac	12873	857	78.3	
14	Scot Scot 453				Not in the QuickLoad database
15	Win 748	13081	891	78.4	
16	Win 760	10151	761	79.8	
17	Win 785	8374	665	80	Not in the QuickLoad database. Simulation ran with Win Supreme 780
18	Winchester Magnum Rifle				Not in the QuickLoad database

Figure 9.4.1: NCFS Suggested Matches for Flattened Ball Propellants Containing Oblong Grains

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The National Center for Forensic Science (NCFS) web site has a database of propellants used to load pistol, rifle and shotgun ammunition. By supplying the basic geometry measurements of the propellant taken from Mr. Batts' Cartridge #3, the website provided a list of potential propellant matches. The NCFS search identified 18 propellants that were flattened ball containing oblong granules. See Figure 9.4.1. Narrowing the search with granule width and granule length, three propellants appeared to be the very similar to the Cartridge #3 propellant: Accurate 2230, Accurate 2520 and Accurate MagPro. See Figure 9.4.2.

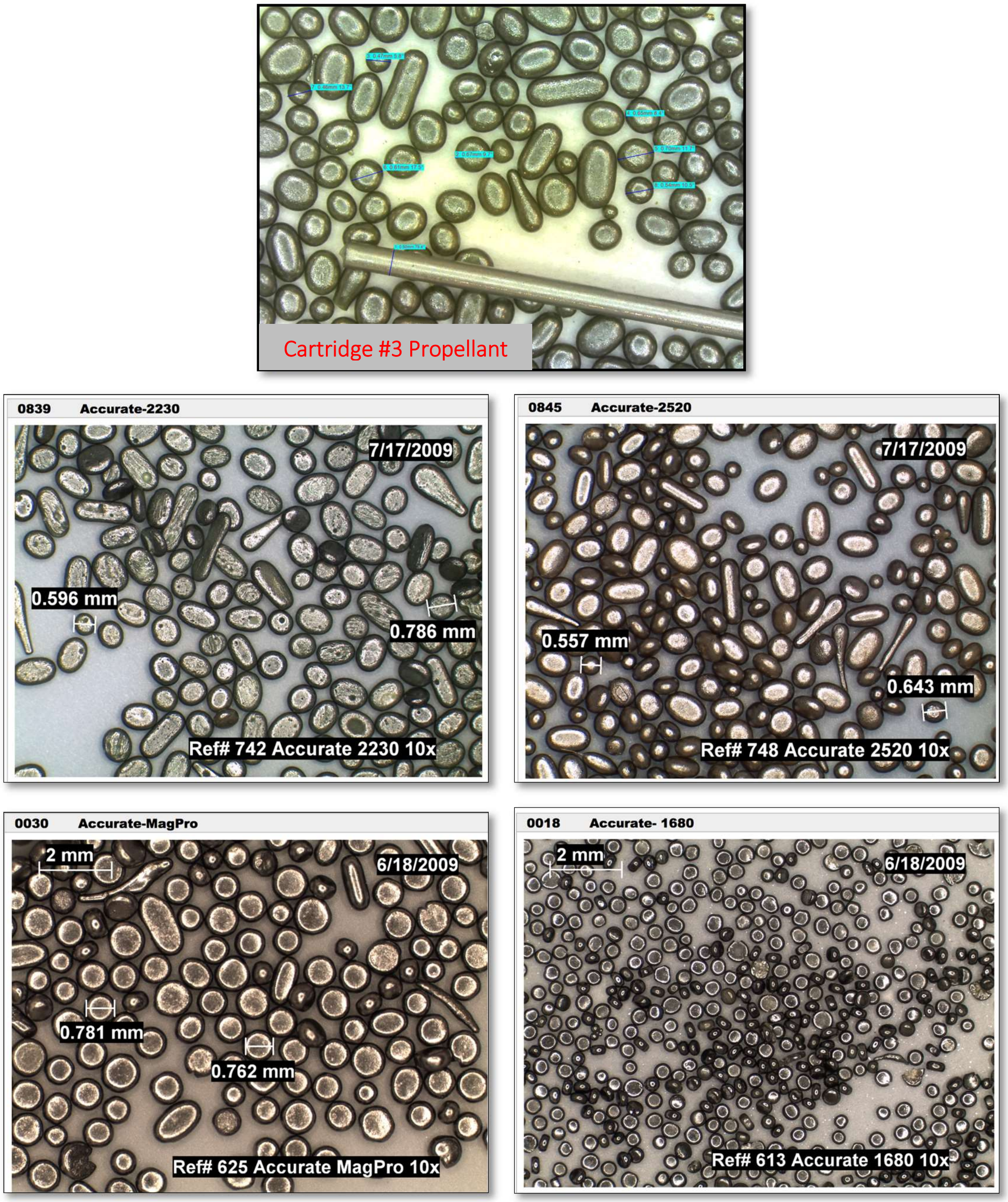

Figure 9.4.2: Propellant Images of Cartridge #3, Accurate 2230, Accurate 2520, Accurate MagPro and Accurate 1680

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The Accurate 1680 propellant was included in Figure 9.4.2 to contrast the difference between the propellant observed in Cartridge #3 and an approved 300 Blackout propellant such as Accurate 1680. The Accurate 1680 propellant does not contain the oblong granules observed in Cartridge #3 and the size of the 1680 granules were slightly smaller than the granules observed in Cartridge #3.

Hornady's 9th edition *Handbook of Cartridge Reloading* does not recommend loading a 208 grain 300 Blackout subsonic cartridge to produce a max pressure less than 24,000 psi. To analytically investigate the performance characteristics of each of the four identified propellants when loaded into a 300 Blackout cartridge matching Mr. Batts' Cartridge #3 (10.3 grains of propellant, 208 grain Hornady 308 ELD-M Bullet and 2.242 inch COL), QuickLoad was used to simulate the pressure vs. time curve for each propellant. QuickLoad is a commercial interior ballistics program used by most major ammunition manufacturers to aid in ammunition development. Interestingly, each of the non 300 Blackout propellants produced max pressures that were below 13,000 psi and unsafe. See Figure 9.4.3.

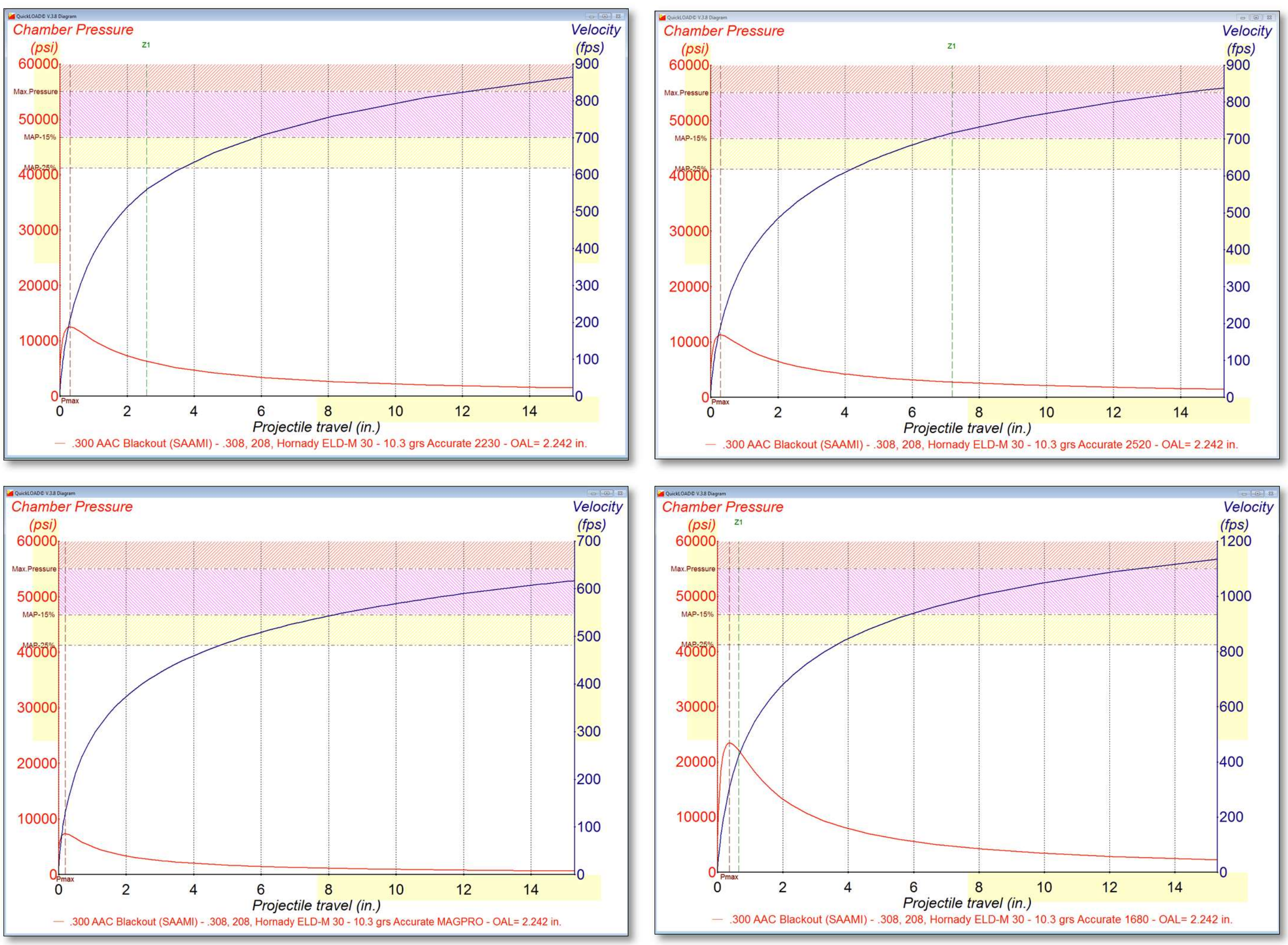

Figure 9.4.3: QuickLoad's Predicted Pressure Characteristics for Accurate 2230, Accurate 2520, Accurate MagPro and Accurate 1680

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As discussed earlier, a bullet has an interference fit with the rifling of a barrel. Therefore, the minimum pressure required to drive a bullet down and out a barrel must be greater than the drag forces acting on the bullet caused by the interference fit. This minimum bullet drive force can vary from rifle to rifle due to many factors, including: the roughness of the rifling; uniformity of the rifling; geometry of the rifling; type of ammunition being fired; and the number or rounds that have been fired through the barrel. The minimum amount of pressure required to propel a 300 Blackout bullet down a barrel was calculated to be approximately 4000 to 6000 psi. Figure 9.4.3 shows the predicted Accurate 2230, Accurate 2250 and Accurate MagPro propellant pressures drop below the necessary drag force minimum pressure of 4000 psi within approximately 4 inches of travel down the barrel. Therefore, the ability of the bullet to exit the barrel after 4 inches of travel is dependent on the energy of the bullet at 4 inches (velocity and mass) and the pressure behind the bullet from 4 inches to the muzzle.

QuickLoad does not predict if a bullet will stop in the barrel. At these low pressures, the burn rates of propellants can become inconsistent due to the rising significance of the bullet to barrel drag factor as an overall percentage of the pressure produced, among other noise variables. It is for these reasons that QuickLoad warns that ballistic calculation at low pressures are unreliable and that a loader should NEVER load a cartridge below the loading manual's minimum.

To investigate if Accurate 2230, 2250, Magpro and 1680 propellants can lodge a 300 Blackout 208 grain bullet in the barrel of a H&R Handi-Rifle, six cartridges of each propellent type were constructed with propellant charges of 5.3, 6.3, 7.3, 8.3, 9.3 and 10.3 grains. See Figure 9.4.4. All three non 300 Blackout propellants (Accurate 2230, 2250, and Magpro) lodged the bullet in the barrel with a 10.3 grain propellant charge. The Accurate 1680 propellant (an approved 300 Blackout propellant) did not lodge the bullet in the barrel until the propellant charge was reduced to 5.3 grains. The performance of the Accurate 1680 is significant because it did not lodge a bullet in the barrel until it was reduced to 47% of the *Hornady Handbook of Cartridge Reloading* recommended average charge of 11.3 grains. This charge reduction is very similar to the downloaded 40% factory Hornady Subsonic 300 Blackout charge that lodged the bullet in the barrel during the testing discussed in Section 9.2.

Ammunition Brand	Propellant Charge (grains)	Engagement (in)	Bullet Lodged in the Barrel	Shell Expelled	Notes
Accurate MagPro	5.3 – 10.3	0.000	Yes	Yes	Brass expulsion occurred with a 10.3 grain charge
Accurate 2520	5.3 – 10.3	0.000	Yes	Yes	Brass expulsion occurred with a 10.3 grain charge
Accurate 2230	5.3 – 10.3	0.000	Yes	Yes	Brass expulsion occurred with a 10.3 grain charge
Accurate 1680	5.3 – 10.3	0.000	Yes	Yes	Brass expulsion occurred with a 5.3 grain charge

Figure 9.4.4: Accurate Propellants Performance vs Propellant Charge Amounts

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The deleted video that was recovered from Mr. Batts' GoPro camera (GOPR5587) shows that Mr. Batts experienced a squib load with the bullet lodged at the barrel. During the alternate propellant testing, the 10.3 grain load of Accurate 2230 also lodged a bullet at the muzzle, in a fashion that appears to be identical to Mr. Batts' first squib load. See Figure 9.4.5. While the Accurate 2520 lodged the bullet in the barrel with 10.3 grains of propellant (14.25 inches from the breech face, just shy of the muzzle), 6.3 grain charge of Accurate 2520 lodged the bullet at the muzzle (15 inches from the breech face, protruding from the muzzle). These observed differences in where Accurate 2520 lodged the bullet in the barrel are perfect examples of how the bullet-to-barrel drag forces vary, and how the pressures developed by improperly loaded and under loaded cartridges are unreliable, as warned against by QuickLoad.

Figure 9.4.5: Mr. Batts' First Squib Load Compared to Squib Loads Produced in Testing.

The live fire testing of propellants geometrically similar to the propellant observed in Mr. Batts' Cartridge #3 showed that, if the rifle was unlocked (0.000 engagement) and the incident cartridges were loaded with 10.3 grains of Accurate 2230, Accurate 2520, Accurate Magpro or similar propellants, the discharged shell would have been expelled from the chamber when the bullet lodged in the barrel. The live fire testing also showed that if the incident cartridge was loaded with 10.3 grains of Accurate 1680 or a similar appropriate 300 Blackout propellant, that the incident bullet would not have become lodged in the barrel and the action would not have opened.

The live fire alternative propellant testing was also conducted with the test rifle locked with an engagement less than 0.060 inches. At no time during this testing was the discharged shell expelled from the rifle. When the bullets became lodged in the barrel, the rifle remained locked with the discharged shells in the chamber.

9.5) <u>Propellant's Effect on Shell Expulsion Time</u>

As discussed in section 6, the incident video shows the time elapsed between the hammer hitting the firing pin and the discharged brass being expelled from the rifle as 25 milliseconds (audio analysis). The highspeed video of the live fire testing affords the opportunity to analyze the rate a discharged improperly loaded 300 Blackout shell is expelled from an unlocked H&R Handi-Rifle. Figure 9.5.1 shows a comparison between a

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300 Blackout cartridge 40% underloaded with factory Hornady Subsonic 300 Blackout propellant and a 300 Blackout cartridge loaded with 10.3 grains of an improper 308 Win propellant (Accurate 2520).

Figure 9.5.1: Shell Expulsion Time vs. Propellant Type

One of the primary differences between the 300 Blackout propellants and the Accurate 2230, 2520 and MagPro propellants is the burn rate. The 2230 (5.52mm NATO propellant)

burns faster than the 2520 (a 308 Win Service propellant), which burns faster than the MagPro (a magnum rifle propellant). Typically, the smaller the case capacity, the faster the propellant burns. Subsonic 300 Blackout cartridges have less capacity than 5.56mm NATO cartridges, which have less capacity than 308 Win Service cartridges, which have less case capacity than 300 Win Mag cartridges. To lodge a bullet in the barrel and expel the discharged shell from the rifle's chamber, the underloaded 300 Blackout subsonic propellant took 61 milliseconds, 36 milliseconds longer than Mr. Batts improperly loaded incident cartridge. The improper 308 Win Service propellant (Accurate 2520) took 26 milliseconds to lodge the bullet in the barrel and expel the discharged shell, only 1 millisecond longer than the incident cartridge. The slower burn rate of the Accurate 2520 keeps the pressure up by burning longer. The last highspeed video frame of the Accurate 2520 discharge in Figure 9.5.1 shows the propellant is still burning as the shell is being expelled (flame is coming from the chamber). When the factory Hornady 300 Blackout propellant shell is expelled, no flame can be observed coming from the chamber, indicating that propellant had finished its burn.

This examination of the effect propellant types has on shell expulsion time via highspeed video strongly indicates Mr. Batts' incident 300 Blackout cartridge was not loaded with an improper amount of 300 Blackout propellant, but was rather loaded with an incorrect amount of inappropriate propellant, similar to the 308 Win Service propellant type used in the ammunition Mr. Batts was shooting through his M1A rifle approximately 20 minutes before the incident.

9.6) <u>Live Fire Testing Results</u>

Interestingly, it was noted that as the live fire count of the exemplar test rifle increased, the force required to drive the lodged bullets out of the barrel became less. This reduction of bullet-to-barrel drag forces was most probably due to the barrel break-in that typically occurs during the first 200 rounds of discharging a new rifle. Mr. Batts' rifle was reported to be new, indicating the bullet-to-drag forces should have been at their greatest when the incident occurred.

The analytical analyses and live fire testing presented conclusively disprove Mr. Powell's root cause opinion that Mr. Batts was injured by the discharge of a SAAMI compliant 300 Blackout cartridge in a H&R Handi-Rifle (with a compromised lockup of approximately 0.062 inches). Therefore, Mr. Powell's rendered root cause opinion is not correct. If Mr. Powell had conducted any testing with factory SAAMI compliant 300 Blackout ammunition and a H&R Handi-Rifle in the partially locked or unlocked condition, Mr. Powell would have disproven his own opinion. None of the physical "testing" Mr. Powell conducted served to prove or disprove his opinion of root cause in any way.

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Throughout all of the live fire testing I have conducted in investigating the Batts incident, I have discharged no less than 139 rounds of 300 Blackout ammunition through an exemplar H&R Handi-Rifle (98 unlocked and 41 locked with less than 0.060 inches of engagement). In none of the test firings did factory SAAMI compliant 300 Blackout ammunition lodge a bullet in the barrel (locked or unlocked). In none of the test firings was the discharged brass expelled from the rifle if the rifle was locked (all locked tests were conducted with less than 0.060 inches of engagement). In the 139 rounds of 300 Blackout ammunition discharged, the only way the discharged brass was expelled from the rifle was when the rifle was discharged unlocked and the discharged cartridge was improperly loaded well below the SAAMI specifications. Mr. Batts was injured because he was shooting improperly loaded 300 Blackout ammunition that prevented the H&R Handi-Rifle from locking and produced unsafe low pressures.

10) Incident Full Reconstruction

Mr. Batts use of a GoPro video camera before and during the incident affords us the rare opportunity to catalogue each event that lead up to the expulsion of the discharged shell. Combining the deleted video (GOPR5587) with the incident video (GOPR5588) yields the timeline shown in Figure 10.1.1.

Time (min:sec)	Event
0:00	Mr. Batts fires Shot 1 – The first bullet lodges in the barrel
3:37	Mr. Batts pulls a bore snake (cleaning implement) through the barrel
8:18	Mr. Batts pours CLP into the chamber
8:39	Mr. Batts fires Shot 2 – The bullet clears the barrel
9:11	Mr. Batts fires Shot 3 – The bullet lodges in the barrel and the shell was expelled (the incident shot)

Figure 10.1.1: Batts' Incident Timeline Derived from the GoPro Videos

To conclusively determine if Mr. Batts incident could have occurred with a locked H&R Handi-Rifle (0.062 inch engagement per Mr. Powell), four test cartridges were loaded with an improper propellant (Accurate MagPro) and the exemplar test rifle was configured with a compromised lockup of less than 0.060 inches. The test rifle was then discharged using the timeline (including the activities such as applying the CLP following the first shot) derived from the GoPro as a guide. The first shot did lodge in the barrel, the second shot did clear the barrel and the third shot did lodge in the barrel. However, because the rifle was partially locked, the action did not open, and the discharged shell was not expelled on the third shot. To fully duplicate Mr. Batts incident, the third shot had to be discharged with the rifle unlocked. See Figure 10.1.2.

To be clear, to reproduce Mr. Batts incident, the first shot was discharged with the rifle partially locked (the bullet lodged in the barrel and the action did not open). The second shot was discharged after the CLP had been added to the chamber and the rifle was partially locked (the bullet cleared the barrel). And, the third shot was discharged with the

rifle unlocked[3] (0.000 inch engagement between the barrel catch and barrel lug), which allowed the improper propellant to lodge the bullet in the barrel and the trapped pressure to open the action and expel the discharged shell. When the rifle is locked or partially locked, the trapped pressure cannot force the rifle open and the pressure dissipates through leakage. Therefore, Mr. Batts' incident was caused by Mr. Batts use of improperly formed and improperly loaded non factory Subsonic 300 Blackout ammunition. The improperly formed cartridge prevented the rifle from locking closed and the use of an improper propellant charge prevented the discharged bullet from clearing the barrel.

Figure 10.1.2: Incident Reconstruction

Lastly, analysis of the incident GoPro video shows a 25 millisecond time difference from when the hammer strikes the firing pin to when the discharged shell is expelled. Analysis of the highspeed video of the unlocked discharge of the MagPro propellant cartridge that duplicated the Mr. Batts incident showed a shell expulsion time of 24.7 milliseconds, which rounds to 25 milliseconds, an exact match of the incident shell expulsion time. The incident reconstruction testing reproduced Mr. Batts' incident precisely.

[3] The shims used in the earlier testing to adjust the amount of lockup the rifle could achieve were replaced with an adjustment screw in the receiver and under the barrel lug. See Figure 10.1.2. By turning the screw, the rifle's lockup could be more easily reduced or increased to the desired test level.

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11) Examination of the Plaintiff's Expert's Rendered Opinion of Root Cause and Testimony

Mr. Powell (expert for the plaintiff) was deposed with respect to Jon Batts v Remington Arms, LLC on June 19, 2019. It is the job of a product liability expert to employ their specialized training and experience to investigate the root cause of an incident objectively, via analysis and testing, and then render opinions of root cause with a reasonable degree of engineering and scientific certainty that are verified and verifiable through the fore mentioned analysis and testing. Mr. Powell rendered an opinion that Mr. Batts injuries were caused by a dangerously defective H&R Handi-Rifle while shooting SAAMI compliant ammunition. Mr. Powell arrived at this opinion through "damage" he observed on the incident rifle's barrel. Mr. Powell did not recreate the incident through testing. Mr. Powell did not conduct a mechanical analysis of the rifle. See Testimony Page 69.

Q	Have you performed any mechanical engineering analysis of the locking mechanism?
A	No.

Testimony Page 69: Mr. Powell did not conduct a Mechanical Engineering Analysis

Figure 11.1 shows the subject barrel lug. The lug's surfaces show no signs of denting, cracks or alteration. The lug does show signs of contact wear caused by the barrel catch (silver areas), indicating the action had been opened and closed several times. Mr. Powel has stated the barrel lug is damaged and has pointed to the wear areas on the lug. Technically wear is damage, localized disruption of a surface due to repeated contact between two surfaces, but the wear observed will do nothing to alter the mechanical performance of the rifle. Close examination of the barrel lug's engagement surface show linear machining marks running from right to left across the surface (red arrows). The observed breaks in the wear pattern match the machining marks.

Q	So here is my question. Are you able to identify any damage caused to this piece of metal, the barrel lug, as a result of it being caused -- it being forcibly disengaged from the barrel catch at the time of the incident?
A	You mean distinguish that particular firing as opposed to any other firing?
Q	Yes, sir.
A	No, you can't distinguish between the damage of the different firings. It's all right there together at the edge of the barrel lug.

Testimony Page 173: Mr. Powell could not Identify Specific Damage Related to the Incident

For the subject rifle's action to have opened from a locked or partially locked position at the time of the incident, the mechanics of the mechanism would have had to change substantially. Mr. Powell has identified no such demonstrable change and has testified he

cannot identify any specific "damage"/wear which occurred and was caused because of the incident. See Testimony Page 173.

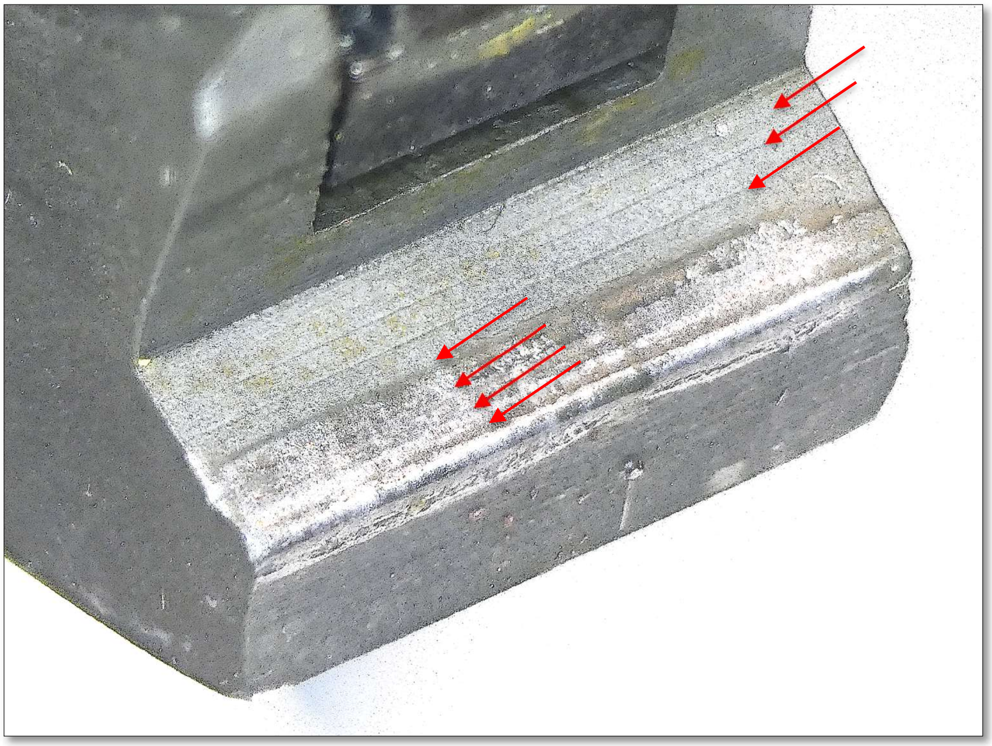

Figure 11.1: Subject Barrel Lug Wear and Machining Marks

Mr. Powell has not provided analysis or explanation as to how the wear/"damage" identified is evidence the mechanical function of the rifle changed and allowed the action to open under normal use. When questioned with respect to testing conducted to support this claim, Mr. Powell stated his inspection of the rifle was a test.

Q	Do you consider examination of the bullet in the bore, just an examination of those items, tests?
A	Sure. It's a visual inspection and measurement.
Q	So in your view, a test would include an examination, visual inspection of a piece of evidence?
A	Visual examination is certainly a type of nondestructive testing, as well as measurement, as well as evaluation of x-rays and CAT scans. All of those are tests.

Testimony Page 43: Mr. Powell States an Object can be Tested by Looking at it.

Mr. Powell represented that visual inspection of evidence can constitute testing the evidence. See Testimony Page 43. Visually "testing" for a defect requires matching an observation with a known defect's root cause. For example, if a piece of metal has

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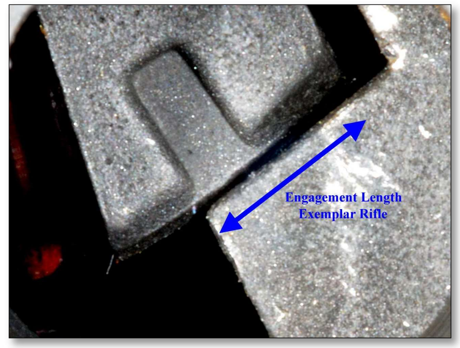
fractured, the fracture surfaces can be examined via a scanning electron microscope and the images of the fracture can be compared to documented metal failures and help identify the root cause of the metal piece in question. Failure reference photos are the foundation of non-destructive reference testing. This is a common form of metal failure analysis but does require known and verified references to conduct. With respect to the subject rifle, a valid visual test of the barrel lug would require having photos of a barrel lug that was known to have blown open from a locked condition and then comparing those photos to the subject rifle's barrel lug. Mr. Powell made no such visual reference comparison tests. Reaching conclusions without sound data to base those conclusions on is not a reliable, trustworthy methodology an engineer should and must apply in investigating an incident such as Mr. Batts' incident.

Q How would normal contact wear between the barrel lug and the barrel catch look any different than what we see in the Batts rifle, the subject rifle?
A You expect fuller contact, deeper contact between the two, and you would expect smooth surface markings between the two, not these -- these fractured ridges at the edge of the -- of the barrel lug like you see in the Batts rifle.
Q When you say -- I think you used the word "deeper contact." What are you referring to? The length of engagement?

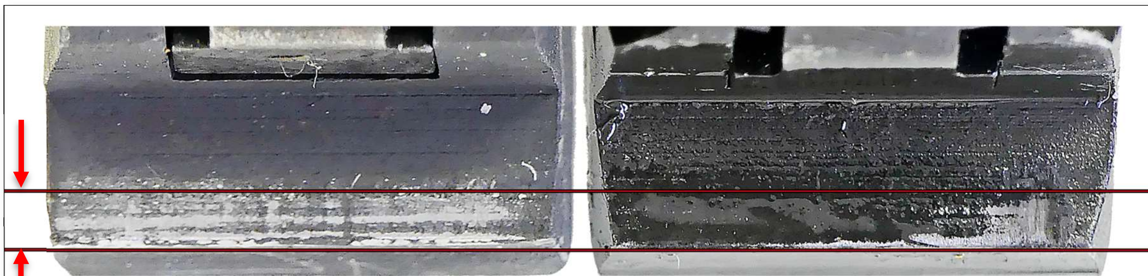
Testimony Page 176: Mr. Powell States that Normal Wear on the Lug Would be Deeper

Identifying the root cause of mechanical failure requires a fundamental understanding of how the mechanism works to properly identify abnormalities. Mr. Powell testified the wear marks on the barrel lug indicated a defect because they were not "deep" enough. See Testimony Page 176. As discussed in Section 5, the depth of contact between the barrel catch and the barrel lug does not linearly correlate with the amount of overlap between the barrel catch and the barrel lug. Mr. Powell tested an exemplar rifle with the maximum "GO" engagement. However, the depth of wear marks on the exemplar's barrel lug are no deeper than the subject rifle's barrel lug. See Figure 11.2. Close examination of Mr. Powell's exemplar barrel lug wear shows not only the wear mark depth is equivalent to the subject barrel lug's, but also shows the contact was primarily being made of the right side of the lug. Taken as a whole, the exemplar rifle had less locking engagement than the subject rifle yet did not open in any of Mr. Powell's thrust force measurement firings. Science is founded on consistent and repeatable results. If the depth of engagement is a factor in an H&R Handi-Rifle blowing open during discharge, the subject rifle and Mr. Powell's appear to be equivalent in this regard


Subject Rifle's Lockup



Mr. Powell's Exemplar Lockup


Subject Rifle's Barrel Lug Wear

Mr. Powell's Exemplar Barrel Lug

Figure 11.2: Dept of Barrel Lug Wear Compared

As stated earlier, Mr. Powell did not conduct any mechanical analysis of the rifle. A lack of analysis can lead to poor assumptions and false conclusions. Mr. Powell testified he had not used the GoPro video to calculate how long it took the rifle to blow open at the time of the incident. When asked about how long a discharged 300 Blackout bullet is in the barrel, Mr. Powell estimated between 3 and 10 milliseconds. See Testimony Page 46. Because Mr. Powell has conducted no mechanical analysis of the rifle, his understanding and estimates about how it works are deeply flawed. SAAMI compliant 300 Blackout ammunition has a bullet-in-barrel time between .8 and 1.3 milliseconds, considerably less than Mr. Powell's minimum estimate. This is extremely significant because a failure to understand how long the rifle's action had to open means a failure to understand what could or could not open the rifle in that time period. As shown in Section 6, a cursory analysis of the GoPro video shows the incident could not have been caused by a SAAMI compliant cartridge because of the long action-opening time.

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Q	Other than that damage that you just mentioned, is there any other basis for your conclusion that the force of the shot caused the barrel lug to disengage from the barrel catch?
A	No.
Q	What was the force?
A	I don't know.
Q	Over what period of time was it applied?
A	During the period of time that the shell discharged.
Q	What was that?
A	I haven't measured it off of the video. A very short period of time. Milliseconds.
Q	Do you know how long in a 300 Blackout -- 200-grain, 300 Blackout round takes to exit a 16-inch barrel under normal circumstances?
A	No.
Q	Do you have an estimate?
A	Several -- several milliseconds.
Q	What's the range?
A	I -- I don't know.
Q	More than three?
A	Probably more than three. Less than 10.
Q	Is that the best estimate you can give? More than three, less than 10 milliseconds?
A	Yes, and that's an estimate.

Testimony Page 46: Mr. Powell Estimates Bullet-In-Barrel Time

The job of an expert engineer is to bring a level of knowledge and understanding to the challenge of identifying root cause in a scientific and verifiable way. Mr. Powell's opinion of root cause contradicts fundamental physics principles and is wholly unverified (and unverifiable).

12) Safe Gun Handling Practices

It is the responsibility of every firearm user to understand how to safely operate his or her firearm. Remington provides an Owner's Manual in the box of every firearm it manufactures. The subject rifle was produced with instructions on how to safely load, discharge and unload the firearm. Similar safe firearms handling practices are also taught in hunter's education courses across the United States. The shooting incident would have been avoided if Mr. Batts had followed the Ten Commandments of safe gun handling presented in the Remington Owner's Manual. The following safe gun handling practices were not followed by Mr. Batts:

1. Use proper ammunition. Using the wrong ammunition, mixing ammunition or using improperly reloaded ammunition can cause serious personal injury or death; and
2. Failed to stop using the improperly loaded and defective ammunition when the first shot lodged the first bullet in the chamber;

13) Case Materials Reviewed in Reaching Opinions

To date and in the preparation of this report, I have reviewed the following:

- The subject rifle and its components;
- Photographs, videos, CT Scans, X-rays and physical test results of the rifle and ammunition;
- Photographs, videos and physical test results of the exemplar rifle and ammunition;
- Notice of Claim;
- Petition;
- Owner's manual produced by the plaintiff;
- Charles Powell's produced file;
- Plaintiff's & Remington's Discovery Responses and Production;
- All Photos produced by plaintiff, including all of Charles Powell's photos.
- Two videos produced by Plaintiff
- Remington Supplemental Production - Drawings
- Plaintiff's Rule 26 Disclosures, including Powell's report.
- Data image of the GoPro memory card;
- GoPro Video GOPR5586, GOPR5587 and GOPR5588;
- Chuck Powell's Invoices;
- Batts' Facebook page in PDF format;
- Remington's Discovery Responses;
- Remington's produced documents;
- Deposition of Jon Batts;

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- Deposition of Jennifer Batts;
- Deposition of Charles Powell;
- Report – Charles Powell;
- Supplemental Report – Charles Powell;
- Report – Chief, Game Warden;
- Report – Abbreviated Ground Accident Report; and
- Remington H&R 1871 Handi-Rifle Owner's Manual.

Exhibits which I may use to explain or support the opinions expressed at trial include the afore-mentioned materials along with exemplar rifles, exemplar fire controls, cutaways, computer simulations, videos and other demonstrative exhibits.

14) Conclusions & Opinions

Based on my education, training, and experience in product design, firearm design, ammunition design and manufacture, my review of the information regarding the circumstances of the shooting, and my inspection of the subject rifle, subject ammunition, and testing of the exemplar rifle and exemplar ammunition, I offer the following opinions to a reasonable degree of engineering and scientific certainty[4]:

- The subject rifle discharged and expelled the shell into Mr. Batts' eye because Mr. Batts used improper, non-factory, non-SAAMI compliant 300 Blackout ammunition;
- No defects were found in the condition and functionality of the rifle that would cause the rifle's action to open and the shell to be expelled when the rifle was discharged;
- No defects were found in the design or manufacture of the rifle that which were in any way related to the shooting;
- The subject rifle is safe in design and manufacture for its intended and reasonably foreseeable uses;
- All physical testing and functioning confirmed that the action of the rifle would not open and forcefully expel the discharged cartridge if the rifle was fired in the locked or partially locked condition;

[4] All opinions I set forth in this report are to a reasonable degree of engineering and scientific certainty.

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- All physical testing and functioning confirmed that the action of the rifle would open and forcefully expel the discharged shell only if the rifle was fired in the unlocked condition with an improper cartridge;
- The incident cartridge was a reload (non-original factory cartridge);
- The incident cartridge was not SAAMI compliant;
- The incident cartridge contained an improper propellant charge that produced inadequate pressures to propel the bullet out of the rifle's barrel, causing the bullet to become lodged in the barrel;
- The incident cartridge was improperly formed and prevented the rifle from locking when closed;
- The rifle and its locking mechanism do not possess any unreasonably dangerous manufacturing defects;
- The rifle and its locking mechanism do not possess any unreasonably dangerous manufacturing defects which are causally related to the shooting or Mr. Batts injuries;
- The rifle will not expel the discharged shell of a SAAMI compliant cartridge when fired in the locked condition.
- The rifle will not expel the discharged shell of a SAAMI compliant cartridge when fired in the partially locked condition.
- The rifle will not expel the discharged shell of a SAAMI compliant cartridge when fired in the unlocked condition.
- Mr. Batts caused the shooting incident that injured him in the following manner:
  - Mr. Batts loaded a live round of improper ammunition into the rifle's chamber;
  - Mr. Batts closed and locked the rifle's action on the improper cartridge;
  - Mr. Batts cocked the rifle's hammer and pulled the trigger on the improper cartridge (Shot 1), causing the bullet to lodge in the barrel and the action to remain closed;
  - Mr. Batts removed the lodged bullet from the barrel with a ramrod;
  - Mr. Batts did not cease using the defective ammunition;
  - Mr. Batts removed the lodged bullet and lubricated the chamber and barrel of the rifle with CLP;
  - Mr. Batts loaded a second live round of improper ammunition

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into the rifle's chamber;

- Mr. Batts closed and locked the rifle's action on the second improper cartridge;
- Mr. Batts cocked the rifle's hammer and pulled the trigger on the second improper cartridge (Shot 2), causing the bullet to exit the barrel and the rifle's action to remain closed;
- The discharge of Shot 2 removed most of the CLP from the bore of the rifle's barrel;
- Mr. Batts loaded a third live round of improper ammunition into the rifle's chamber;
- Mr. Batts closed but did not lock the rifle's action due to the use of the improper third round of ammunition.
- Mr. Batts cocked the rifle's hammer and pulled the trigger on the third improper cartridge (Shot 3), causing the bullet to lodge in the barrel and the rifle's unlocked action to open; and
- Mr. Batts use of the third improper cartridge caused the propellant gasses to become trapped in the barrel behind the lodged bullet and those trapped gasses to propel the shell out of the chamber;

- The shooting was caused by Mr. Batts' negligent, careless and reckless failure to follow safe gun handling practices including:
  - Failure to use proper ammunition;
  - Failure to follow the warnings in owner's manual for the rifle;
  - Failure to properly reload / hand load ammunition (if he reloaded the ammunition) or using ammunition reloaded from an unknown source (if his testimony about that is correct); and
  - Failure to stop using the improper ammunition after the first shot lodged the bullet in the barrel;
- Mr. Powell (expert for the plaintiff) has provided no testing or physical evidence to substantiate his opinion of root cause.
- No evidence exists that suggests the subject H&R Handi-Rifle was the root cause of Mr. Batts' incident,

I reserve the right to change and supplement my opinions and conclusions following my examination of any additional case materials presented, including depositions.

Date: 07-15-2019
This report was prepared and authored by:

Derek Watkins
____
Derek L Watkins
President & Chief Engineer
Nth-Level. LLC.

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Appendix

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Appendix A: Live Fire Test Matrix (Page 1)

H&R 300 Blackout Testing History											
Test Number	Date	Engagement (in)	Ammunition Type (Factory/Hand Load)	Ammunition Brand	Bullet Weight (grains)	Propellant Amount	Velocity	Bullet Lodged in the Barrel (Yes/No)	Shell Expelled (Yes/No)	Shot Fired	Notes
1	8/17/17	0.000	Factory	Remington	120	Factory	Supersonic	No	No	1	High speed video set to 10,000 fps.
1	8/17/17	0.000	Factory	Remington	120	Factory	Supersonic	No	No	2	
1	8/17/17	0.000	Factory	Remington	120	Factory	Supersonic	No	No	3	
1	8/17/17	0.000	Factory	Sig	220	Factory	Subsonic	No	No	4	
1	8/17/17	0.000	Factory	Sig	220	Factory	Subsonic	No	No	5	
1	8/17/17	0.000	Factory	Sig	220	Factory	Subsonic	No	No	6	
2	8/17/17	0.000	Factory	Remington	120	Factory	Supersonic	No	No	7	
2	8/17/17	0.000	Factory	Remington	120	Factory	Supersonic	No	No	8	
2	8/17/17	0.000	Factory	Remington	120	Factory	Supersonic	No	No	9	
2	8/17/17	0.000	Factory	Sig	220	Factory	Subsonic	No	No	10	
2	8/17/17	0.000	Factory	Sig	220	Factory	Subsonic	No	No	11	
2	8/17/17	0.000	Factory	Sig	220	Factory	Subsonic	No	No	12	
3	1/9/19	0.000	Factory	Sig	125	Factory	Supersonic	No	No	13	
3	1/9/19	0.000	Factory	Sig	125	Factory	Supersonic	No	No	14	
3	1/9/19	0.000	Factory	Sig	125	Factory	Supersonic	No	No	15	
4	1/9/19	0.000	Factory	Sig	220	Factory	Subsonic	No	No	16	
4	1/9/19	0.000	Factory	Sig	220	Factory	Subsonic	No	No	17	Lost a shim and barrel locked closed. The shim was replaced for the next shot. The high speed video was not recorded due to the loss of the shim.
4	1/9/19	0.000	Factory	Sig	220	Factory	Subsonic	No	No	18	
4	1/9/19	0.000	Factory	Sig	220	Factory	Subsonic	No	No	19	
5	1/9/19	0.000	Factory	Hornady	110	Factory	Supersonic	No	No	20	
5	1/9/19	0.000	Factory	Hornady	110	Factory	Supersonic	No	No	21	
5	1/9/19	0.000	Factory	Hornady	110	Factory	Supersonic	No	No	22	
6	1/9/19	0.000	Factory	Hornady	208	Factory	Subsonic	No	No	23	
6	1/9/19	0.000	Factory	Hornady	208	Factory	Subsonic	No	No	24	
6	1/9/19	0.000	Factory	Hornady	208	Factory	Subsonic	No	No	25	
7	1/9/19	0.000	Factory	Remington	120	Factory	Supersonic	No	No	26	
7	1/9/19	0.000	Factory	Remington	120	Factory	Supersonic	No	No	27	
7	1/9/19	0.000	Factory	Remington	120	Factory	Supersonic	No	No	28	
8	1/9/19	0.000	Factory	Remington	220	Factory	Subsonic	No	No	29	
8	1/9/19	0.000	Factory	Remington	220	Factory	Subsonic	No	No	30	
8	1/9/19	0.000	Factory	Remington	220	Factory	Subsonic	No	No	31	
9	1/9/19	0.000	Factory	Sig	125	Factory	Supersonic	No	No	13	Changed the high speed video frame rate to 20,000 fps and changed the view to capture the entire rifle
10	1/9/19	0.000	Factory	Sig	220	Factory	Subsonic	No	No	33	
11	1/9/19	0.000	Factory	Hornady	110	Factory	Supersonic	No	No	34	High speed video camera was out of position and the test had to be repeated (shot 35)
11	1/9/19	0.000	Factory	Hornady	110	Factory	Supersonic	No	No	35	
12	1/9/19	0.000	Factory	Hornady	208	Factory	Subsonic	No	No	36	
13	1/9/19	0.000	Factory	Remington	120	Factory	Supersonic	No	No	37	
14	1/9/19	0.000	Factory	Remington	220	Factory	Subsonic	No	No	38	
15	1/9/19	0.000	Factory	Federal	150	Factory	Supersonic	No	No	39	
15	1/9/19	0.000	Factory	Federal	150	Factory	Supersonic	No	No	40	
15	1/9/19	0.000	Factory	Federal	150	Factory	Supersonic	No	No	41	
16	1/10/19	0.000	Factory	Federal	220	Factory	Subsonic	No	No	42	
16	1/10/19	0.000	Factory	Federal	220	Factory	Subsonic	No	No	43	
16	1/10/19	0.000	Factory	Federal	220	Factory	Subsonic	No	No	44	
17	1/10/19	0.000	Factory	Winchester	125	Factory	Supersonic	No	No	45	
17	1/10/19	0.000	Factory	Winchester	125	Factory	Supersonic	No	No	46	
17	1/10/19	0.000	Factory	Winchester	125	Factory	Supersonic	No	No	47	
18	1/10/19	0.000	Factory	Winchester	200	Factory	Subsonic	No	No	48	
18	1/10/19	0.000	Factory	Winchester	200	Factory	Subsonic	No	No	49	
18	1/10/19	0.000	Factory	Winchester	200	Factory	Subsonic	No	No	50	

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Appendix A: Live Fire Test Matrix (Page 2)

H&R 300 Blackout Testing History

Test Number	Date	Engagement (in)	Ammunition Type (Factory/Hand Load)	Ammunition Brand	Bullet Weight (grains)	Propellant Amount	Velocity	Bullet Lodged in the Barrel (Yes/No)	Shell Expelled (Yes/No)	Shot Fired	Notes
19	1/10/19	0.000	Hand Loaded	Hornady	208	90% Factory	Subsonic	No	No	51	Factory Hornady subsonic ammunition was torn down and reassembled with a reduced propellant. The factory propellant was reused.
19	1/10/19	0.000	Hand Loaded	Hornady	208	80% Factory	Subsonic	No	No	52	
19	1/10/19	0.000	Hand Loaded	Hornady	208	70% Factory	Subsonic	No	No	53	
19	1/10/19	0.000	Hand Loaded	Hornady	208	60% Factory	Subsonic	No	No	54	
19	1/10/19	0.000	Hand Loaded	Hornady	208	50% Factory	Subsonic	No	No	55	
19	1/10/19	0.000	Hand Loaded	Hornady	208	40% Factory	Subsonic	Yes	Yes	56	Bullet did not exit the barrel
20	1/17/19	less than 0.060	Hand Loaded	Hornady	208	40% Factory	Subsonic	Yes	No	57	
21	1/17/19	less than 0.060	Hand Loaded	Hornady	208	40% Factory	Subsonic	Yes	No	58	
22	1/17/19	less than 0.060	Hand Loaded	Hornady	208	40% Factory	Subsonic	Yes	No	59	
23	5/10/19	0.000	Hand Loaded	Hornady	208	10.3 grains Acc MagPro	Subsonic	Yes	Yes	60	Bullet stuck in the barrel approximately three inches from the muzzle. Shell was ejected. No video of the test.
24	5/10/19	0.000	Hand Loaded	Hornady	208	10.3 grains Acc 2520	Subsonic	No	No	61	No video of the test.
25	5/10/19	0.000	Hand Loaded	Hornady	208	10.3 grains Acc 1680	Subsonic	No	No	62	No video of the test.
26	5/10/19	0.000	Hand Loaded	Hornady	208	10.3 grains Acc 2230	Subsonic	Yes	Yes	63	Bullet stuck in the barrel at the muzzle. Replicated Batts' first shot. Shell was ejected. No video of the test.
27	6/13/19	0.000	Factory	Hornady	110	Factory	Supersonic	No	No	64	CLP in the chamber before the shot
27	6/13/19	0.000	Factory	Hornady	208	Factory	Subsonic	No	No	65	CLP in the chamber before the shot
28	6/13/19	0.000	Factory	Sig	125	Factory	Supersonic	No	No	66	CLP in the chamber before the shot
28	6/13/19	0.000	Factory	Sig	220	Factory	Subsonic	No	No	67	CLP in the chamber before the shot
28	6/13/19	0.000	Factory	Sig	220	Factory	Subsonic	No	No	68	CLP in the chamber before the shot
29	6/13/19	0.000	Factory	Federal	150	Factory	Supersonic	No	No	69	CLP in the chamber before the shot
29	6/13/19	0.000	Factory	Federal	220	Factory	Subsonic	No	No	70	CLP in the chamber before the shot
30	6/13/19	0.000	Factory	Winchester	125	Factory	Supersonic	No	No	71	CLP in the chamber before the shot
30	6/13/19	0.000	Factory	Winchester	200	Factory	Subsonic	No	No	72	CLP in the chamber before the shot
31	6/13/19	0.000	Factory	Remington	120	Factory	Supersonic	No	No	73	CLP in the chamber before the shot. High speed recorded but the standard video was cut short due the camera card became full.
31	6/13/19	0.000	Factory	Remington	220	Factory	Subsonic	No	No	74	CLP in the chamber before the shot. High speed recorded but the standard video was cut short due the camera card became full.
31	6/13/19	0.000	Factory	Remington	120	Factory	Supersonic	No	No	75	CLP in the chamber before the shot. Reshot due to the standar video being cut short on the earlier shots.
31	6/13/19	0.000	Factory	Remington	220	Factory	Subsonic	No	No	76	CLP in the chamber before the shot. Reshot due to the standar video being cut short on the earlier shots.
32	6/13/19	Less than 0.060	Factory	Hornady	110	Factory	Subsonic	No	No	77	CLP in the chamber before the shot. Less than 0.060 Engagement
32	6/13/19	Less than 0.060	Factory	Hornady	208	Factory	Subsonic	No	No	78	CLP in the chamber before the shot. Less than 0.060 Engagement
33	6/14/19	Less than 0.060	Factory	Sig	125	Factory	Supersonic	No	No	79	CLP in the chamber before the shot. Less than 0.060 Engagement
33	6/14/19	Less than 0.060	Factory	Sig	220	Factory	Subsonic	No	No	80	CLP in the chamber before the shot. Less than 0.060 Engagement
34	6/14/19	Less than 0.060	Factory	Federal	150	Factory	Supersonic	No	No	81	CLP in the chamber before the shot. Less than 0.060 Engagement
34	6/14/19	Less than 0.060	Factory	Federal	220	Factory	Subsonic	No	No	82	CLP in the chamber before the shot. Less than 0.060 Engagement
35	6/14/19	Less than 0.060	Factory	Winchester	125	Factory	Supersonic	No	No	83	CLP in the chamber before the shot. Less than 0.060 Engagement
35	6/14/19	Less than 0.060	Factory	Winchester	200	Factory	Subsonic	No	No	84	CLP in the chamber before the shot. Less than 0.060 Engagement
36	6/14/19	Less than 0.060	Factory	Remington	120	Factory	Supersonic	No	No	85	CLP in the chamber before the shot. Less than 0.060 Engagement
36	6/14/19	Less than 0.060	Factory	Remington	220	Factory	Subsonic	No	No	86	CLP in the chamber before the shot. Less than 0.060 Engagement
37	6/14/19	Less than 0.060	Hand Loaded	Hornady	208	10.3 grains Acc MagPro	Subsonic	No	No	87	CLP in trhe Chamber. Engagement set to less than 0.060 engagement. The action did not open.
37	6/14/19	Less than 0.060	Hand Loaded	Hornady	208	10.3 grains Acc MagPro	Subsonic	No	No	88	No CLP in the Chamber. Engagement set to less than 0.060 engagement. The action did not open.
38	6/14/19	Less than 0.060	Hand Loaded	Hornady	208	10.3 grains Acc 2520	Subsonic	No	No	89	CLP in trhe Chamber. Engagement set to less than 0.060 engagement. The action did not open.
38	6/14/19	Less than 0.060	Hand Loaded	Hornady	208	10.3 grains Acc 2520	Subsonic	No	No	90	No CLP in the Chamber. Engagement set to less than 0.060 engagement. The action did not open.
39	6/14/19	Less than 0.060	Hand Loaded	Hornady	208	10.3 grains Acc 1680	Subsonic	No	No	91	CLP in trhe Chamber. Engagement set to less than 0.060 engagement. The action did not open.

EXHIBIT 2

Appendix A: Live Fire Test Matrix (Page 3)

H&R 300 Blackout Testing History

Test Number	Date	Engagement (in)	Ammunition Type (Factory/Hand Load)	Ammunition Brand	Bullet Weight (grains)	Propellant Amount	Velocity	Bullet Lodged in the Barrel (Yes/No)	Shell Expelled (Yes/No)	Shot Fired	Notes
39	6/14/19	Less than 0.060	Hand Loaded	Hornady	208	10.3 grains Acc 1680	Subsonic	No	No	92	No CLP in the Chamber. Engagement set to less than 0.060 engagement. The action did not open.
40	6/14/19	Less than 0.060	Hand Loaded	Hornady	208	10.3 grains Acc 2230	Subsonic	No	No	93	CLP in trhe Chamber. Engagement set to less than 0.060 engagement. The action did not open.
40	6/14/19	Less than 0.060	Hand Loaded	Hornady	208	10.3 grains Acc 2230	Subsonic	No	No	94	No CLP in the Chamber. Engagement set to less than 0.060 engagement. The action did not open.
Cleaned the CLP from the barrel and then fired five factory Hornady subsonic rounds to season the barrel											
41	6/14/19	Less than 0.060	Hand Loaded	Hornady	208	10.3 grains Acc MagPro	Subsonic	No	No	100	
41	6/14/19	Less than 0.060	Hand Loaded	Hornady	208	9.3 grains Acc MagPro	Subsonic	No	No	101	
41	6/14/19	Less than 0.060	Hand Loaded	Hornady	208	8.3 grains Acc MagPro	Subsonic	No	No	102	
42	6/14/19	Less than 0.060	Hand Loaded	Hornady	208	10.3 grains Acc 2520	Subsonic	Yes	No	103	The action did not open. The bullet was approximately 13 inches from the breech face.
42	6/14/19	Less than 0.060	Hand Loaded	Hornady	208	9.3 grains Acc 2520	Subsonic	No	No	104	
42	6/14/19	Less than 0.060	Hand Loaded	Hornady	208	8.3 grains Acc 2520	Subsonic	No	No	105	
43	6/14/19	Less than 0.060	Hand Loaded	Hornady	208	10.3 grains Acc 1680	Subsonic	No	No	10	
43	6/14/19	Less than 0.060	Hand Loaded	Hornady	208	9.3 grains Acc 1680	Subsonic	No	No	107	
43	6/14/19	Less than 0.060	Hand Loaded	Hornady	208	8.3 grains Acc 1680	Subsonic	No	No	108	
44	6/14/19	Less than 0.060	Hand Loaded	Hornady	208	10.3 grains Acc 2230	Subsonic	No	No	109	
44	6/14/19	Less than 0.060	Hand Loaded	Hornady	208	9.3 grains Acc 2230	Subsonic	No	No	110	
44	6/14/19	Less than 0.060	Hand Loaded	Hornady	208	8.3 grains Acc 2230	Subsonic	Yes	No	111	The action did not open. The bullet was approximately 12 inches from the breech face.
45	6/14/19	0.000	Hand Loaded	Hornady	208	10.3 grains Acc 2230	Subsonic	No	No	112	
45	6/14/19	0.000	Hand Loaded	Hornady	208	9.3 grains Acc 2230	Subsonic	No	No	113	
45	6/14/19	0.000	Hand Loaded	Hornady	208	8.3 grains Acc 2230	Subsonic	Yes	Yes	114	The bullet was approximately 11 inches from the breehface.
46	6/17/19	0.000	Hand Loaded	Hornady	208	10.3 grains Acc MagPro	Subsonic	No	No	115	
46	6/17/19	0.000	Hand Loaded	Hornady	208	9.3 grains Acc MagPro	Subsonic	No	No	116	
46	6/17/19	0.000	Hand Loaded	Hornady	208	8.3 grains Acc MagPro	Subsonic	No	No	117	
46	6/17/19	0.000	Hand Loaded	Hornady	208	7.3 grains Acc MagPro	Subsonic	No	No	118	
46	6/17/19	0.000	Hand Loaded	Hornady	208	6.3 grains Acc MagPro	Subsonic	Yes	Yes	119	The bullet was approximately 9.75 inches from the breehface.
46	6/17/19	0.000	Hand Loaded	Hornady	208	5.3 grains Acc MagPro	Subsonic	Yes	Yes	120	The bullet was approximately 6 inches from the breehface.
47	6/17/19	0.000	Hand Loaded	Hornady	208	10.3 grains Acc 2520	Subsonic	Yes	Yes	121	The bullet was approximately 14.25 inches from the breehface.
47	6/17/19	0.000	Hand Loaded	Hornady	208	9.3 grains Acc 2520	Subsonic	No	No	122	
47	6/17/19	0.000	Hand Loaded	Hornady	208	8.3 grains Acc 2520	Subsonic	No	No	123	
47	6/17/19	0.000	Hand Loaded	Hornady	208	7.3 grains Acc 2520	Subsonic	No	No	124	
47	6/17/19	0.000	Hand Loaded	Hornady	208	6.3 grains Acc 2520	Subsonic	Yes	Yes	125	The bullet was approximately 15 inches from the breehface.
47	6/17/19	0.000	Hand Loaded	Hornady	208	5.3 grains Acc 2520	Subsonic	No	No	126	
48	6/17/19	0.000	Hand Loaded	Hornady	208	10.3 grains Acc 1680	Subsonic	No	No	127	
48	6/17/19	0.000	Hand Loaded	Hornady	208	9.3 grains Acc 1680	Subsonic	No	No	128	
48	6/17/19	0.000	Hand Loaded	Hornady	208	8.3 grains Acc 1680	Subsonic	No	No	129	
48	6/17/19	0.000	Hand Loaded	Hornady	208	7.3 grains Acc 1680	Subsonic	No	No	130	
48	6/17/19	0.000	Hand Loaded	Hornady	208	6.3 grains Acc 1680	Subsonic	No	No	131	
48	6/17/19	0.000	Hand Loaded	Hornady	208	5.3 grains Acc 1680	Subsonic	Yes	Yes	132	The bullet was approximately 9.5 inches from the breehface.
49	6/17/19	0.000	Hand Loaded	Hornady	208	7.3 grains Acc 2230	Subsonic	No	No	133	
49	6/17/19	0.000	Hand Loaded	Hornady	208	6.3 grains Acc 2230	Subsonic	No	No	134	
49	6/17/19	0.000	hand Loaded	Hornady	208	5.3 grains Acc 2230	Subsonic	Yes	Yes	135	The bullet was approximately 9 inches from the breehface.
50	6/17/19	Less than 0.060	Hand Loaded	Hornady	208	6.3 grains Acc MagPro	Subsonic	Yes	No	136	Incident Reconstruction, First Shot. The bullet was approximately 7.5 inches from the breehface.
50	6/17/19	Less than 0.060	Hand Loaded	Hornady	208	6.3 grains Acc MagPro	Subsonic	No	No	137	Incident Reconstruction, Second Shot.
50	6/18/19	Less than 0.060	Hand Loaded	Hornady	208	6.3 grains Acc MagPro	Subsonic	Yes	No	138	Incident Reconstruction, Third Shot with less than 0.060 Engagement. The bullet was approximately 13 inches from the breehface.
50	6/19/19	0.000	Hand Loaded	Hornady	208	6.3 grains Acc MagPro	Subsonic	Yes	Yes	139	Incident Reconstruction, Third Shot with 0.000 Engagement. The bullet was approximately 10 inches from the breehface.

EXHIBIT 2